Space Weather Technical Forecast

Issued on Tuesday, 17 January 2023 at 12:45 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further R1/R2 Radio Blackouts Likely. Chance of G1/Minor Geomagnetic Storms from day 2 (18th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity became Low through the past 24 hours, with X-ray flares recorded at GOES16 peaking with a C9.4 at 17/0013 UTC. This flare emanated from AR3192. This region has continued to grow and remains magnetically complex (Fsi/Beta-Gamma). The largest region on the disk AR3190 (Eki/Beta-Gamma-Delta) has also produced some C flares and continues to show signs of growth. The remaining seven numbered and two unnumbered regions appear stable and magnetically simple. Though weak delta spots have been evident in some regions and these may re-emerge?
No new Earth-directed CMEs have been observed in available coronagraph imagery. Though there are numerous mostly small filaments on the disc at present, however the largest currently straddles the solar meridian near 30S and is probably the main candidate to lift-off the Sun.

Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by DSCOVR, has been slightly elevated around 450 km/s. The solar wind density has been average or slightly above average. The IMF has been weak below 6nT. The north-south component has varied between -2/+3 nT. The phi angle was predominantly positive (away from the Sun) for the duration.
The net effect of the above solar wind measures was for provisionally Quiet to Unsettled Kp indices, (Kp1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has been at Background levels throughout.
High energy electron flux (greater than 2 MeV) has been Background to Moderate. The 24-hour integrated electron fluence stayed below the Active threshold, but with an increasing trend, reaching 1.92e7 integrated pfu by 17/0001 UTC.

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Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to be Moderate, with a daily Slight Chance of reaching High levels. There are numerous regions on the disk with the most obvious significant flare candidates AR3190 and AR3192. Further active regions are expected to emerge, though we will lose AR3182 which has produced several significant flares during its transit across the disk.

Solar Wind / Geomagnetic Activity: Solar winds are expected to soon revert to a slow regime, resulting in Quiet geomagnetic activity for the remainder of day 1 (17 January). Later on day 2 (Wednesday 18 January), a fast wind of the order 450-500 km/s is expected due to CH65/+ and/or CH66/+. Any CIR leading the fast wind may combine with the 14 January CME from the AR3182 twin M-flares later day 2 or into day 3 (Thursday 19 January), giving a chance of G1 minor geomagnetic storms. Towards the end of day 4 (20th January) we may see the arrival of a fast wind from CH68 this maintains the chance of a G1 storm through this period.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is likely to remain at predominantly Background levels, but with a Slight Chance of enhancements to S1 or greater through the period due to a number of magnetically complex sunspot regions on the visible disc.
The high energy electron flux (greater than 2 MeV) is expected to continue at largely Moderate levels, possibly with a slight upward trend on days 1 or 2 (17th/18th), probably still insufficient for the corresponding electron fluence to breach Active (1e8 integrated pfu). A reduction in counts is then likely to follow any CME or fast wind activity for a time.

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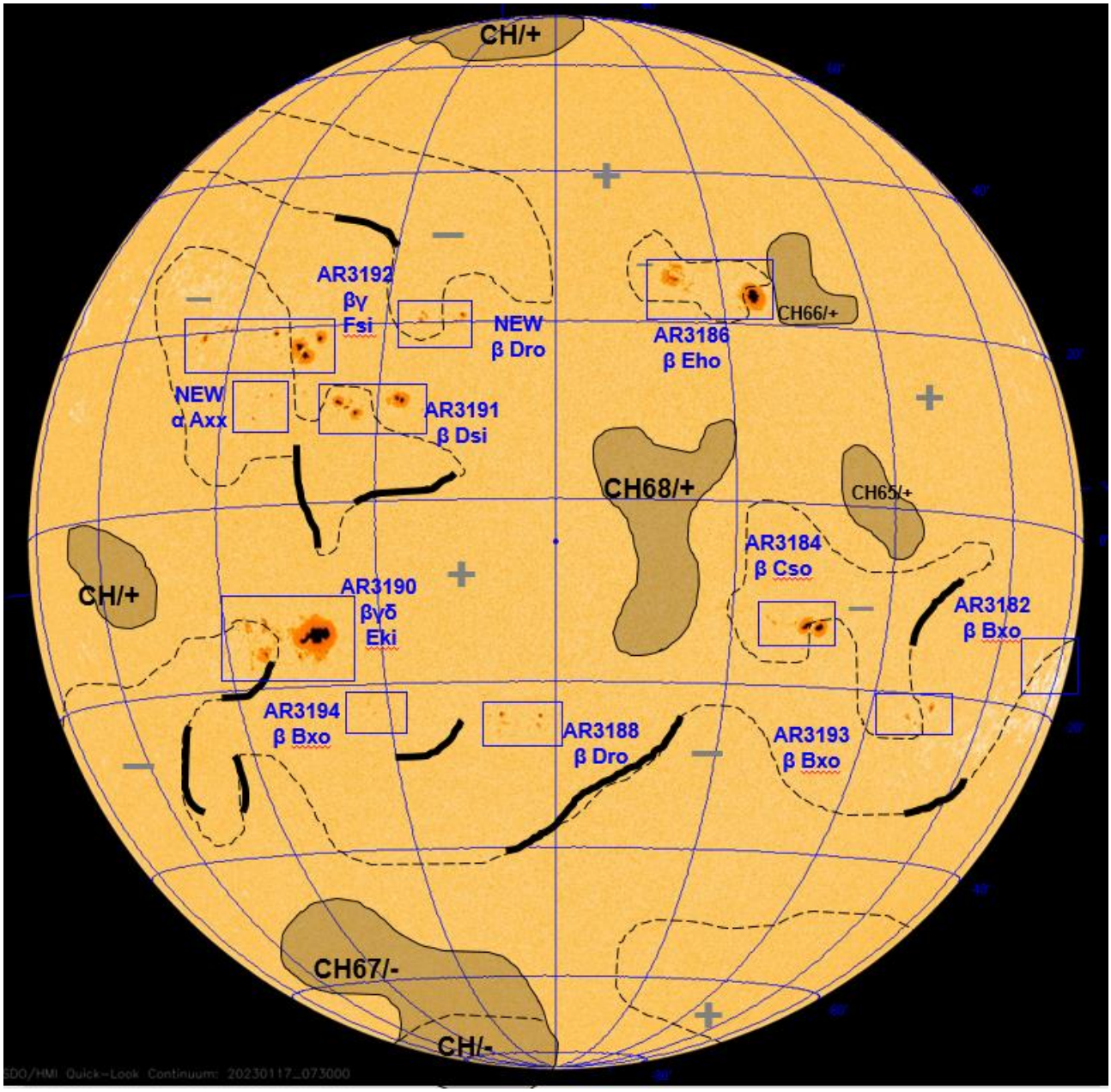
Figure 1. Solar Analysis Valid 17/0800 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

This forecast period comprises an initial waning of residual 11 January CME effects, followed by the risk of concurrent arrival of a possible CIR leading CH65 and/or 66 later day 2 (18th) with any 14 January CME influence.

As such, the most reliably Quiet period of the forecast should be day 1 (17th) and perhaps the first half of day 2 (18th), with a Chance of Minor Geomagnetic Storm G1 from late day 2 for the remainder of the period with the possibility of a fast wind from CH68 arriving later on day 4 (20th).

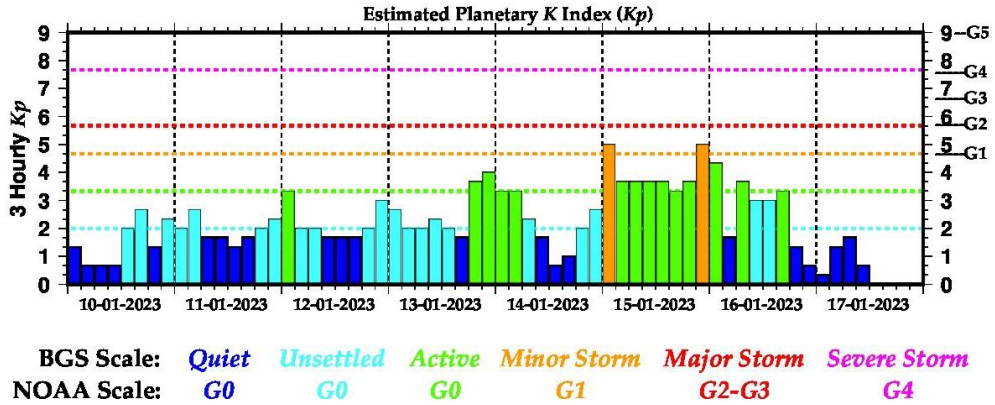
CH65 and 66 are not particularly representative of their states on the previous rotation, and as such persistence methods are somewhat unsafe, however MOSWOC Enlil does suggest that a fast wind of up to around 500 km/s may arrive, with any CIR perhaps bolstered by a glance from the 14 January twin-M-class CME from near AR3182. The phasing of all of these features is of lower confidence, but given the weight of contributors, at least some degree of enhanced geomagnetic activity is expected, and this is very likely to represent the peak for the four-day period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	50	50	40
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/0900UTC	Partial	AR3182	SW	400km/s	18/2359UTC	Glancing blow possible.

Figure 2: BGS Kp



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Radio Blackouts - X-Ray Flares:

Solar activity has become Low through the past 24 hours. This is perhaps somewhat surprising given the complex and congested solar disc, however it is likely to be a measure of the constituent spot groups' maturity and slowing growth trends (with the main exception of AR3190 and AR3192 in the east).
Sunspot region AR3182 should rotate from the Earth-facing side by day 2 (18th), however far-side soundings suggest further regions are to be expected on the opposite horizon, probably acting to maintain a Likely daily risk of M-class flares, although this has been slightly revised downwards given the quiescent X-ray flux trace and the slight decrease in the 10.7cm flux versus the UTC weekend peak.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	70	70	70	70
Very Active	R3 to R5 X Class	No	10	10	10	10

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is currently at background levels.
While no recent S1+ events have been observed at GEO, the sheer number of both front and far-sided complex groups dictates an elevated risk. While the relative contribution to risk will decrease through the UTC working week for Ex-AR3181 and eventually (by then Ex-)AR3182, the weight of sunspot regions in the eastern solar hemisphere will increasingly bring itself to bear, resulting in a relatively constant Slight Chance of S1+ through the four days.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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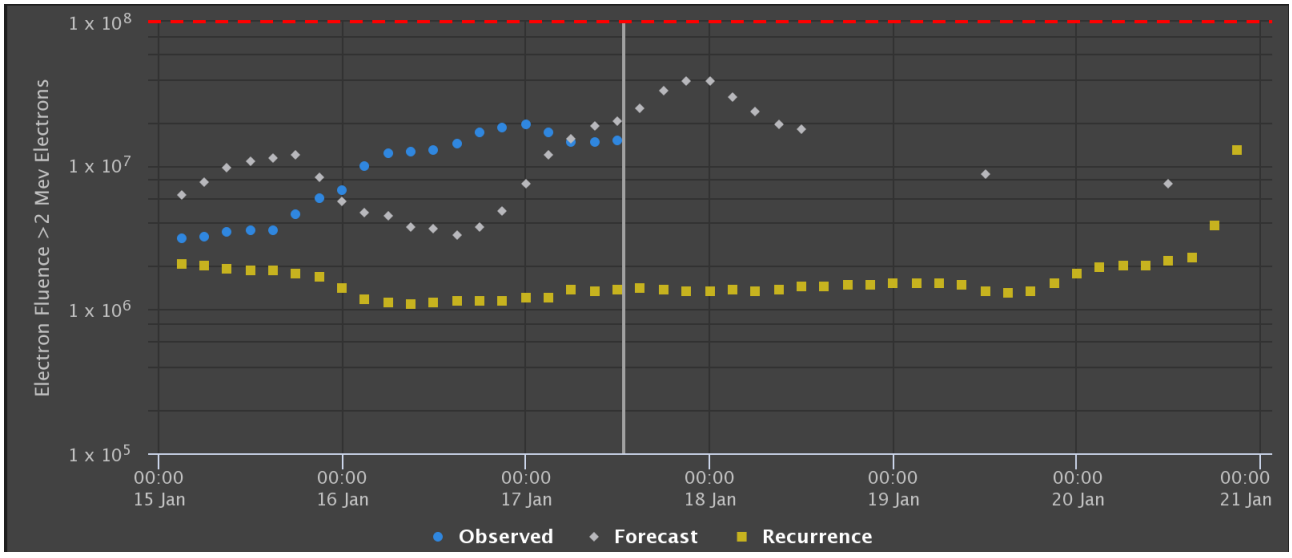
High Energy Electrons Event (≥ 2MeV):
High energy electron flux is oscillating between normal background and Moderate levels as part of the normal diurnal variation. The recent fast wind from CH62/- and effects from the recent CME are continuing to tail off, but have yet to manifest in any increased magnitude oscillation. However it is more likely than not that it will elicit some form of upward reaction over days 1 and 2 (17th/18th). The degree to which this occurs will most likely prove insufficient for 24-hour Active fluence to be realised, given the modest duration and intensity of the fast wind. Persistence methods are not considered useful in the period given the apparent lack of similarity of the current disc with last rotation, as well as the presence of CMEs, however REFM is in agreement in the persistence of a sub-Active trend.
All considered, there is a slightly upward trend possible in flux and fluence in the immediate term, as recently seen, probably saturating within 24 hours before increased geomagnetic activity likely acts to temporarily suppress electron counts at GEO from later on day 2 (Wednesday 18 January).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	30	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: MOSWOC REF Model expected to remain below 1e8 Active level.



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